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ABSTRACT

This report presents a discussion of important issues surrounding the use of interactive instructional technology by vocational educators. It considers interactive instructional television system components with special attention to system interface considerations, software considerations, and design and development of interactive instructional television lessons and programs. Designing programs to accommodate two distinct types of information, i.e., promoted inputs along the program's normal course of preparation and user-initiated interruptions is addressed, as is screen design. Other topics include the menu-branching capabilities and the testing/assessment implications of interactive instructional television. The instructional, psychological, and job-related impact is also discussed. A scenario of the design and use of a sample interactive instructional television program is presented. A final section details results of the project, including identification of the technical equipment and definitions of the educational technology needed to develop effective educational packages. (YLB)

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FINAL REPORT

Submitted to

Research Coordinating Unit
Division of Occupational Education & Technology
Texas Education Agency

For the
Exemplary and Innovative Project

entitled

DEVELOP AND DEMONSTRATE THE USE OF INTEGRATED INSTRUCTIONAL DELIVERY SYSTEMS FOR APPLICATION IN TECHNICAL/VOCATIONAL EDUCATION

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ABSTRACT

This report is devoted to relating the results of an exploration of promising new technology for use by vocational educators--interactive instructional technology. The effort was conducted under an exemplary and innovative project funded by the Texas Education Agency under Public Law 94-482, Subpart 3, Section 130.

The evolution of micro-computer technology and advances made in videorecorders have resulted in the availability of cost-effective instructional strategies that were viewed as being science fiction a few short years ago. While the symbiotic relationship between video and computer technologies is becoming increasingly apparent, judged by the large number of hardware systems appearing in the market place, the use by educators of available technology is limited. Much greater use is seen in private industry.

Utilizing micro-computer control, which allows for branching instruction, users of interactive instructional television systems can access segments of various videotaped instructional material with speed and accuracy.

The learner receives information, is asked questions, and required to respond electronically using a responder device. Feedback is immediate and can be personalized, with the information's level of difficulty precisely controlled so as to match the individual's level of idiosyncratic pace and rate of learning. Remedial information can be presented in the interactive system automatically, and it is possible, with some systems, to record and evaluate the learner's performance.

The systems available today provide for varying levels of interactivity--depending primarily on the cost of the system one elects to work with. Exceedingly complex systems utilizing laser videodisc playback units and expensive microcomputers can provide a very high degree of interactivity. In contrast, low-cost personal computers can be used with low-cost home-type videotape recorder playback units (VCR's) to provide a reasonable degree of interactivity--economically. With such systems, students can be presented videotaped segments of information, and then required to respond by entering the code appearing next to the answer they believe is correct. If a student's answer requires a particular feedback segment, the videocassette player can access that particular segment before continuing to the next instructional segment.

The multistimuli available with interactive instructional television allow contextual learning which-research has repeatedly shown-leads to enhanced transfer and recall of information learned.

This final report will present a discussion of important issues surrounding the use of this new instructional technology and, as well, detail results gained as the project addressed these specific objectives listed in the project's request for proposal:

Objective 1. To Develop a package in given high technology sub-

ject matter areas, to be delivered via interactive video instructional means, which teaches both cognitive and psychomotor skills.

Objective 2. To identify the technical requirements of persons and equipment needed to develop a cost-effective integrated, interactive instructional television system.

Objective 3. To define appropriate high technology subject matter content areas for which the integrated, interactive instructional television delivery system promises to be most applicable and cost effective.

Objective 4. To define the educational technology needed to develop efective educational packages for delivery via the integrated, interactive instructional television approach.

INTERACTIVE INSTRUCTIONAL TELEVISION SYSTEM COMPONENTS

Interactive instructional television is a system of communication in which recorded video information is presented (via videotape or videodisc) under computer control to active learners. These learners not only see and hear pictures, words, and sounds which are presented to them, they also make choices affecting the pace and sequence of the presentation itself. This capacity for interaction between the learner and the system allows information delivery to be tailored to the individual learner through a careful blend of interactive systems controls and direct user control. The information presented can be so tailored as to include the precision of the written word, the clarity of graphic design, the immediacy of real life sound, and the persuasive power of the world in motion.

The power and flexibility of interactive instructional television depends a great deal on the large storage capacity of laser discs and Beta or VHS videocassette and on the rapid accurate accessing ability of videotape and videodisc playback equipment. While micro-computer-controlled videotape does not have the search precision and fast retrieval capabilities of its videodisc counterpart, videotape does offer economy and utility for most educational applications. A promising new direction in interactive video technology involves increased integration between video images stored on videotape and computer-generated text and graphics. This is made possible by interface units such as will be discussed in a subsequent section of the report.

Given the various hardware configurations of available interactive instructional television systems, there is obviously some "thing" which ties all components together and allows them to function as an integrated system. This "thing" or interface, responds to electronic signals, activated by an accompanying computer program, allowing a videotape to be seen and heard on the television monitor, or allowing computer text or graphics to be viewed by the trainee, as part of a carefully designed instructional sequence.

The interface, or system "brain", could be a video controller card or an RS-232C communications device. A video controller card is a printed circuit board designed to fit into a peripheral slot on the buss of a given computer. Accessory cables extending from the controller card are then attached to the video monitor and to the videotape player (or videodisc unit.) A link or interface thus made between all the system's components.

An RS-232C is a "universal" or standard data terminal interface that is used commonly between a data terminal and a modem. However, it is now being used as standard interface between micro-computers and their various peripherals. This means that micro-computers and videotape or videodisk players which have RS-232C ports can be linked with this so-called universal interface rather than with a separate video controller printed circuit board.

SYSTEM INTERFACE CONSIDERATIONS

The interface device discussed above functions to interconnect the various components of the interactive video system with the micro-computer. It is through this interface that the instructions pass which function to move the videotape to an appropriate starting point; switches on the video and audio signals, and causes the signals to be displayed on the monitor until the "STOP" command is received. Instructions are also processed through the interface that determines whether the learner will have to read a text screen or answer a question that has been generated by the microcomputer.

Whether or not an interactive video system that uses a video controller card or a RS-232C interface is selected, it will be seen that both devices perform similar functions. That is, specific instructions from the micro-computer program are selected and then translated into functions to be performed by each of the several components of the interactive instructional television system. Typically, these functions are performed.

1. Video and Audio Switching. The source of the images and the audio messages seen and heard by the learner originate either from the microcomputer, or from the videocassette/videodisc player. In developing lesson material the instructional designer determines which audio and/or video source the learner is to see and hear. The micro-computer program then executes this particular function through the interface by actually switching the videocassette/videodisc player or the computer video, "on or off" as called for by the instructional designer. Most interfaces are capable of allowing several switching options. For example, some interface units allow the design of instructional segments which feature:

* Computer video only and no audio
* Videocassette/videodisc player video only and no audio
* Computer video only and Channel One audio
* Computer video only and Channel Two audio

2. Controlling the Videotape Player. In addition to controlling the video and audio signals of the overall system micro-computer, control can be exercised over all of the various functions of the videocassette/videodisc unit. Because of the interface, one can as the course designer, write an instructional program that calls for the videocassette/videodisc unit to shut-down while the computer generates a question to be answered by the learner. In this case, the unit's "STOP" function is activated by the computer via the interface unit. Other videocassette/videodisc commands which can be issued through the interface by the computer, include:

* Play
* Rewind
* Fast Forward
* Pause
* Slow to one-half normal speed
* Play two times the normal speed

Using instructions from the micro-computer the interface also positions the visual medium at the precise starting point appropriate for initiating instruction. For videotape, this positioning is accomplished by the micro-computer counting control track pulses or reading a time code which has been placed on the tape. For videodisc players, the computer program uses digitized frame numbers to locate the appropriate visual segment desired for display to the student.

It is unfortunate that controller cards and accessory cabling are not universally interchangeable among micro-computers, or among videotape and disc players. This is because a video interface is designed by its manufacturer to function with a specific set of operating instructions, with a specific microcomputer and with a specific videocassette or videodisc player. As a rule, it is not possible to use a given manufacturer's controller interface with another manufacturer's accessory cabling or operating software with just any microcomputer. Consequently, before purchasing a system it is advisable to review the performance specifications of the interfaces sold by various manufacturers before committing yourself to either the interface or to specific micro-computer hardware and a software operating system.

INTERACTIVE INSTRUCTIONAL TELEVISION: "SOFTWARE CONSIDERATIONS"

One of the most interesting aspects about interactive instructional television is that no one in this field has yet been formally qualified as being an expert "in it". The technology is so new that, aside from an infrequent workshop here and there, the only way to learn how to produce interactive instructional television

"software" or lessons is to produce one! Since chances are that anyone interested in the technology will come from some other background, the result is that everyone involved in interactive instructional television will be learning one or more new disciplines---filmmaking, video technology, computer programming, or instructional television design. Not only does interactive instructional television integrate these previously unrelated disciplines, it also modifies each one of them in various small but significant ways. For example, a learner can see any one of ten motion sequences in any order. This fact alone would certainly change (or should change) how a filmaker would go about writing, shooting, and editing each scene. And a traditional background in graphic design would offer little direct preparation for the special problems of designing, say, text and pictures for five hundred video tapes still frames that might be incorporated into an interactive instructional television lesson.

THE NEED TO DESIGN FOR THE MEDIUM

The process of designing an interactive instructional television lesson is somewhat like the procedure an architect uses in designing a building. Starting from the client's guidelines which define the purpose of the building, some general information concerning the population that will inhabit the structure, and specific constraints of budget and schedule are obtained. Next, the architect proceeds to create an environment that accomodates not only the stated goals, but also the unstated goals and the unanticipated purposes that the actual users of the building may demand after it is completed. For our purposes we would do well to recall the preoccupation of modern architects with doing what is natural with the materials being used in fabricating structures. In such an "organic" approach to design, the architect treats wood as wood, steel as steel, and avoids trying to make one material behave unnaturally like another material. In designing interactive instructional lessons or teaching materials we need to adopt a similar perspective, asking: Are there any intrinsic qualities of the computer-controlled videocassette/recorder/reproducer which demand certain design approaches from the outset, quite aside from the particular application planned? Available research suggests that there are a number of important considerations to keep in mind in developing interactive instructional television software:

USER CONTROL. Given the random access by which the videotape unit is able to search from any one point on a videocassette or videodisc to any other, it follows that one of the "natural" or "organic" features of any instructional application of this technology concerns providing the user with some measure of control over the pace and sequence of the material. On a basic level this is provided by the controls built into the player (STOP, FAST, SLOW, etc.). Even though control is generally regarded as an essential element for individualized instruction, a surprising number of sophisticated instructional programs (controlled by external computers) provide the learner with a lower level of control over program pace and sequence than that provided by purely "manual" operation of a videotape play back unit.

RAPID PACE. Given the essentiality of the user control feature, it follows that motion sequences prepared for interactive television must gain and keep the viewer's interest continuously, since he or she may decide to skip the rest of a given segment at any time. While exposure to a slow or boring experience can be easily remedied by the viewer, as just described, the opposite extreme--a motion segment so packed with information that it seems to go by much too fast--can always be repeated if necessary. This all points to a need for a "natural" style of preparing software for interactive instructional television. That is, one that is rapidly paced and visually rich in nature.

HIGH QUALITY. An interactive instructional television software dealing with any subject matter requires the design and production of a higher quality end-product than would be required for the same subject presented via any other medium. This is so for several reasons:

A. This need discussed earlier for a rapid pace applies equally well to the quality of motion sequences. For example, suppose that one is videotaping a sequence on the operation of a computer terminal. Not having available the correct close-up of a particular screen or key press you must subsitute another shot. If the substituted shot happened to inadvertently contain erroneous information, the subject could go marching down a learning path containing injurious misleading information while another could conceivably recognize the error and, as a result, lose all faith in the instruction. Interactive instructional television software programs need to be designed so as to bear up under the close scrutiny it will necessarily receive from the learner.

B. Since interactive instructional television lessons are delivered on a television screen, many learner's expectations are set by the standards found in broadcast television, as related to lighting, sets, camerawork, graphics, animations, and special digital effects. In these areas, even local news programs, commercials, and station logos have served to arouse higher viewer expectations that will influence the learner's perception of the quality of instructional software he or she will be viewing. Unfortunately, in educational productions attainment of these effects many times involves what at best can be termed amateurish attempts. The extent to which such amateurism impedes the learning process remains unanswered at the present.

C. Another reason favoring high-quality production centers is the fact that, in most cases, one has little control over the quality of the television receiver or monitor on which the finished instructional program will be viewed. Consequently, one should prepare for the worst, and produce materials that will communicate effectively even on a badly tuned, poor-quality television receiver. This requires that the learning message be well composed and strongly focused in order to survive the eventuality that such a "noisy" channel of communication may be used.

D. Probably the most compelling reason of all for taking special pains to assure quality in interactive instructional television software production is the most practical one. It centers on the fact that, because they are so complex and combine most of the strengths of all other communications media, they tend to take a long time to produce. Though certainly ill advised there nevertheless is a common tendency--when scripts and storyboards have been finally completed--to rush into production and attempt to save time and money by cutting a few corners here and there. When this happens, the result almost invariably is a sloppy product whose poor qualities create such negative impressions on learners that many of the instructional subtleties built into the deeper structure of the program never had a chance to function. For this reason, the care and attention which is afforded design and development considerations need to be matched by an equal degree of care and attention in the production of the interactive instructional television software.

FRAMEMESSAGES. Information presented on text frames, advanced by some form or another of user input. Probably the best way to present text as part of interactive instructional television lessons is to make each frame communicate one message or thought, however short it may be. Then each keypress by the learner becomes a part of the communication. It is the signal by which the user tells the system that he or she has absorbed the last piece of textual information and ready for the next one.

SELF-EVIDENT STRUCTURE. The organization or structure of an interactive instructional television program is not immediately apparent to the viewer. Consequently, those who undertake to produce effective teaching materials for interactive instructional television use need to make sure that they provide appropriate clues. Useful devices to achieve this include nested menu structures, numbered lessons, section titles with running "headers" or "footers" on every frame, and if indicated, explicit "signposts" such as the use of color codes.

VISUAL INFORMATION. It is, of course, obvious that an application of interactive instructional television technology that fails to take advantage of visual imagery--whether via realism of videography or the clarity of inserted graphics--would be wasting a major advantage of this unique instructional medium. Similarly, in cases when a given idea could be communicated either by words alone or by a combination of words and pictures the latter would be, of course a more effective method to use. Visual imagery "works" better than words alone. Hasn't it been said that "one picture is worth a thousand words"?

INTERACTIVE INSTRUCTIONAL TELEVISION PROGRAM DESIGN

Interactive instructional television programs generally have a characteristic "feel", with this being dependent primarily on what they say to us and how they respond to what we "say". A program can have, for example, a clear, distinct flavor (especially when developed by multiple authors). Whatever the program's degree of

coherence, its behavior invariably communicates a set of attitudes towards both the subject matter and the viewer, which can influence the learning process.

In designing interactive instructional television programs, one has the unique opportunity to create coherent programs which are characterized by a particular set of attitudes and predictable behavior that best serves the needs of the learner. This brings up the important question concerning just what is the nature of such an ideal instructional program? For one, it must be "user friendly". "User-friendliness" is a quality that is easily recognizable by computer users. User-friendliness, or its lack, is particularly conspicuous in messages by which the computer asks for user input and in the ways it responds to that input. For example, most would agree that the following message presented by a computer is not very user friendly:

> YOU MUST ANSWER ALL THE FOLLOWING QUESTIONS. IF YOU DON'T YOU WILL NOT BE SHOWN ANY MORE OF THE PROGRAM. PRESS THE '1' KEY TO START THE QUESTIONS.

A more "user friendly" way of communicating the content of the message would be:

> PLEASE ANSWER THE FOLLOWING QUESTIONS. TO BEGIN, PRESS "1"

This message is not only courteous, it is also brief. By avoiding cluttering up the screen with extraneous information, the instructional designer shows appropriate consideration for the learner's time. To be "user friendly" a program should address the learner in a tone that is courteous, economical, and to the point.

A programs structure needs to be designed so that it is easy for the user to know where he or she is at any time, and how to move to another part of the program. Consequently, both the writing and the visual aspects of the interactive instructional television program need to be designed so as to routinely insure the utmost clarity of communication, whether in presenting information to be learned, or in the process of quizing the learner to assess his or her mastery of the content presented.

INSTRUCTIONAL INTERACTIONS

All interactive instructional television software programs, from the simplest tutorial to a complex simulation consist of a combination of two distinct types of information: prompted inputs along the program's normal course of presentation and user-initiated interruptions outside of the normal program sequence. Designing programs so as to accomodate both types of interaction greatly improves the program's intelligibility and thus its user-friendliness.

Every interactive software program developed has a "normal" sequence of interactions. These consist of what happens when the learner loads the videotape and presses "PLAY", plus other events

that follow, to include all choices that the learner must input to make the interactive program continue. For example, a "normal" sequence might include a menu frame, the learner's input, and one of five possible instructional segments. With "normal" sequence interactions, the choice is the learner's. However, when to make the choice is controlled by the program itself.

To make the "normal" sequence as simple as possible for the learner, needed interactions should always be clearly prompted on the screen. This means that, throughout any interactive program, the screen should either display some unfolding event, which indicates that the system is in control, or there should be one or more prompts indicating that the learner input is needed to advance the program. The viewer should never have to wait for the system, devoid of action or prompts displayed via the screen.

A very basic consideration that has to be dealt with in developing interactive instructional television software involves program structure; how to subdivide the material to be presented, what kinds of choices should be presented, and when to present choices selected for use.

With respect to choices, too often ignored is the fact that the mere presentation of choices--customarily in the form of a menu--can be in itself an interruption of the learning process. This is because mechanics of program structure intrude upon the learner's concentration on the subject matter--which is, after all, the reason for developing the program in the first place.

For purpose of illustration, assume that you are a first-time viewer of an interactive instructional television program and are unfamiliar with the contents of the program's lessons. If you were to be presented with a choice like this:

WHAT DO YOU WISH TO SEE NOW?

(1) Lesson 1
(2) Lesson 2
(3) Lesson 3

you would be just as well off to choose at random, since you have absolutely no information on which to base an informed choice.

Blind choices like the one just discussed are examples of "empty interactions". While there is some interaction present, the user must input something before the program will continue. The difficulty with this arrangement is that the act of choosing itself contributes nothing to the learner's control or to the communcation of the information for which the interactive component was developed. As a matter of fact, the interruption serves to temporarily stop the learner from thinking about the content being dealt with. It is very important that, during the design phase, every proposed interaction be questioned. The programmer must ask: "Is there a real choice

here? Is this an appropriate point for an interruption of the learning process?"

Another basic type of interaction involves the set of functions or commands by which the learner can interrupt the "normal" sequence of the program. That is, the learner himself or herself decides not only what choice to make, but also when to make it.

A number of user-interrupt functions are provided on the videocassette/videodisc player itself, such as the ability to stop, to scan, to go forward, or to freeze frame. Others can be built into the controlling software program, such as "HELP" and "SKIP". Both of these user-interrupts involve a considerable amount of programming. This is because the branching which has to be set up for each command depends on the specific frame being displayed at the given time.

Obviously, since they are not prompted, user-interrupt functions must not only be easily understood, but also easily remembered. In this connection ease of recall can sometimes be difficult if the input system (keyboard, keypad, etc.) does not have keys which are already labeled with the "right" functions. An important key to developing a successful interactive instructional television software program involves carefully balancing the powers the program turns over to the learner with his or her remembering how to use them!

SCREEN DESIGN CONSIDERATIONS

Perhaps the single most important task in the visual design of interactive instructional television programs involves distinguishing clearly among the different classes of verbal communication presented on text frames. Interactive instructional television lesson material can be handled in one of these visually distinctive frame types:

1. Title frames, such as those announcing the beginning of a major section of the program (and which operate to confirm that a menu choice was correctly received by the system);

2. Information frames describing content (and which incorporate prompts indicating how to advance to the next frame);

3. User-input frames, (such as menus, where user-input is required before the program can continue.)

Color codes, different styles of type face, and the use of lines or other graphic symbols can all be used to help make the frame distinctions clear. For example, the system's message to the learner to come forth with necessary input can be expressed in a special prompt symbol (perhaps color-coded) which appears even on information frames to remind him or her what to do to move on to the next frame.

Other suggestions for improved program screen design include such relatively simple things as:

1. Always assigning titles to menus, so that learners can more easily recall where they have been in the program.

2. Have titles on title frames correspond exactly to the titles presented on the menu frames. Generally, short descriptive titles are much more helpful than comedic "laugh getters", especially the second time through!

3. Avoiding bright colors, especially in backgrounds. This is because bright colors require the monitor to operate at the very edge of its technical capabilities, at high intensity and high chroma saturation. As a result, poor monitors will tend to present a very "noisy" picture. In fact, all monitors tend to have trouble displaying stable, easily legible text if it is presented in a color value that contrasts sharply with the background. Aesthetically, strong colors tend to advance, not recede. This is what a background color should do if the characters are to advance in relation to the background, and operate and facilitate learning. A neutral gray value is recommended as a background for test frames. This is because it recedes optically and provides a middle value against which all possible colors and values can be used. Further, a neutral gray background facilitates the use of small bands of color to serve as color codes (such as for "right" and "wrong" feedback messages.)

CAPABILITIES OF INTERACTIVE INSTRUCTIONAL TELEVISION AND ITS IMPACT ON EDUCATION

Today, when an educator thinks about interactive instructional television, he or she probably conjures up images of expensive microcomputers and complex laser disc video playback units. While this, in fact, does reflect one face of emergent instructional technology, it is by no means the only one. Continuing advances which are being made in the areas of low cost personal or "home" computers and low cost "home" stereo videotape recorder/playback units promise to reduce dramatically the costs involved in exploring the potential inherent in this new method of instruction. These products, developed for the home primarily, permit an instructional materials designer to control and randomly access videotaped instructional materials, and integrate them with computer generated textual displays. As a result, instructionally effective-individualized formats can be presented which are designed to address instructional needs formerly requiring the presence of a "live" instructor, or tutor, for optimal instruction to take place.

MENU BASED BRANCHING CAPABILITIES OF INTERACTIVE INSTRUCTIONAL TELEVISION

A simple, but very powerful feature of interactive instructional television centers on a very simple, but powerful technique.

That is, use of the random access capability of videotaped segments to show students what is contained in a given instructional unit. This can be done by providing a "menu" for the student to examine. This can be accomplished via computer generation, or by insertion on the videotape itself, so that the learner can select a topic. For instance, one could include a menu-feature, which would function much like a data bank. This menu-feature would permit the learner to learn how to use various reference tools (a dictionary, industrial reference manuals, zip code directory, etc.). Using such a feature, the learner could go immediately to an explanation of just what he or she wants to study. It can be seen that the difference between random access interactive instructional television and just viewing linearly presented videotape is like the difference between having a book and a scroll. With a book or random access videotape device, one can locate just the "page" or "chapter" one wants without having to "scroll" through the whole program. In tutorial programs, for example, learners can select only the tutorial segment that they are particularly interested in--or they can select the type of explanation best suited to them: technical, operational, basic overview, and so on.

BRANCHING CAPABILITIES OF INTERACTIVE INSTRUCTIONAL TELEVISION

Specific instructions and other information can be provided quite effectively using the system's branching capabilities. Information can be presented, designed to correct a student's misunderstanding of a particular concept, as revealed by his or her answer to a key question. The branching feature also permits students who understand particular concepts quickly to speed through a teaching program without being bogged down in more explanation then they need to have access to. Interactive systems which allow for multiple branching are also available. These systems can "diagnose" a learner's particular misconceptions, and address them with specific individualized feedback. Rather than merely presenting a segment over and over until the correct response has been given (perhaps by nothing more than the process of elimination), such programs can present the critical information in different term, or by other strategies clarify the apprarent confusion which is indicated by the learner's response.

Some computer-based programs can keep track of patterns of responses, and branch to a specific style or level of explanation according to the student's performance in the learning task.

Also, interactive instructional television systems are available which provide printout or record-keeping options, allowing the teacher to see exactly how the learners responded and how long it took them to respond to the program material presented. Such record keeping provides useful information about the learner's progress, as well as the instructional program itself. The hard copy provided as an end product of this feature can become for documentation purposes a part of a student's record.

SIMULATION POTENTIAL AFFORDED BY INTERACTIVE INSTRUCTIONAL TELEVISION

By analyzing a learner's input, an interactive instructional television system can simulate a real-life interactive process--whether it be on an interpersonal nature or mechanical. While one ordinarily thinks of simulators as being exotic and expensive, it is posssible to produce effective simulations with modestly priced interactive instructional television equipment. In situations where mistakes can be costly, dangerous, or ego-deflating, practicing on a realistic interactive representation can be remarkably effective from an instructional point of view. For example, suppose a secretarial practices vocational student is being trained to deal with visitors in the office. After completing the instruction, the learner is asked whether he or she would like to see what happens when an unexpected visitor is: 1) sent away; 2) told to just walk into another person's office; or 3) asked to leave appropriate information and set up another appointment. The consequences of the response selected are shown in the scenes that follow the situation presented to the student for him or her to respond to. The narrator also explains why the choice was a good one or a poor one, given the circumstances.

In a more direct, first-person style simulation, an interactive program can present a person on the screen with whom the student can talk. To allow practice of sales skills in a distributive education class, the instructor can create a simulation in which the learner, as a salesperson, can make a call on a customer. Depending upon what he or she says-and the overall pattern of the conversation--the learner gets to sell one item, two items, nothing, or even get thrown out of the office! Or, the instructor can come up with a simulation depicting a costomer trying to return a mulfunctioning food processor. If the student viewing it is nice and gives the customer his or her money back without requesting a receipt, the student can see the customer and a cohort gloating about the "scam" they just pulled off. Learners can go through such simulation programs a number of times, trying different techniques that they may never have considered in "real life", and thus be instructed indirectly. Such an approach is especially effective when intuitive approaches are wrong or when the learner seems to have a bit of a "know-it-all" attitude.

ACCURACY OF INTERACTIVE INSTRUCTIONAL TELEVISION "SEARCH AND RETRIEVAL" FUNCTION

Most people have had the frustrating experience of trying to read a book of instructions and getting lost completely in verbiage and static graphics in which seemingly half the important steps are missing. While straight "ordinary" television can be used for instructional purposes, in a step by step fashion, only interactive instructional television provides precise, immediate access to essential information. It can for example, help guide the electronics

vocational student through a logical series of trouble-shooting steps, and after narrowing down the trouble, show him or her how to fix the trouble. This, of course, not only applies to mechanical skills but could equally well be extended to diagnosing management problems or medical conditions.

TESTING/ASSESSMENT IMPLICATIONS OF INTERACTIVE INSTRUCTIONAL TELEVISION

At times, it may be important--instructionally--to communicate to your students something they think they already know. With interactive instructional television programs, you can find out how accurate their perceptions of what they know really are. Here, instead of starting out with information, you start out with a question or series of questions assessing the student's fund of information about the subject being dealt with. Conceivably, they may find out they really study the program to be presented to them.

If it turns out that some of the information presented is redundant the program can skip over the material that the learners do not need---leaving more positive energy for the sections they do need to attend to.

In some cases, you may find that the learner does not need to see the program at all-or conversely, that they need even more basic information before they are ready to tackle the program being dealt with.

Interactive instructional telelvision can increase the effectiveness of testing and assessment: it allows for immediate scoring and/or feedback; and for providing supplementary instruction, if necessary, as part of the test. Instead of being limited to conversational print or diagrams as a means of presenting test items, the method provides for dramatized scenes, moving parts, and realistic sounds, all of which add an important dimension to the scope and face-validity of the assessment being carried out. For example, a very effective assessment approach in vocational office skills education might involve a pre-test in the area of filing. The student is asked to identify the name of each of four filing systems displayed in full color video still-frame on the screen. If all four are identified correctly, the program "skips" the student over that particular instructional segment and goes on to the advanced testing material. This technique is not only an effective motivator, but also can save valuable training and demonstration time.

INSTRUCTIONAL IMPACT

Interactive instructional television has shed an entirely new light on the problem of transmitting information for the purpose of instruction. The new technology is viewed by many learners as being a much less authoritarian or hierarchical form of instruction and communications than traditional linear teaching methods. Institutions

employing interactive instructional television for the storage and dissemination of training information report important beneficial changes in the day to day activities of learners. No longer must students wait for classroom teaching sessions (which may be conducted sporadically) to learn new skills or clarify key concepts. If a learner needs immdiate information on virtually any area of his or her training or education program, such can be made readily available economically, and effectively---at an interactive instructional television teaching station.

PSYCHOLOGICAL IMPACT

In order to understand the value of interactive instructional television, one must fully understand its influence on the individual learner. It is apparent that interactive instructional television in addition to generating more learner participation, has also produced several additional unanticipated effects. For example, a number of educators have commented on the increased level of self-sufficiency among learners. They note that the privacy and concentration required to use the new technology produces a learner who tends to be more independent and "subject-involved".

Because interactive instructional television emphasizes personal involvement, independent problem-solving, and self-initiated information retrieval, astute educators believe that this educational technology has helped to produce more mature learners who require less supervision in learning. It is also clear that the technology's capacity to allow user control over the instructional process has functioned to nurture such attitudes as increased confidence, self-reliance, and creativity.

Importantly, there has been absolutely no evidence uncovered to suggest that the new technology contributes to development of feelings of depersonalization or other negative reactions. The concerns that have been voiced by some educators that unrestrained technological intrusion into the classroom might cause isolation and other undesireable effects have been based primarily on opinions and assumptions of educators. Many of these educators have not yet actually used or tested interactive instructional television. Of significance is the fact that actual users report increased satisfaction and improved learning effectiveness among students who have been afforded an opportunity to work with an individualized instructional approach such as interactive instructional television affords.

JOB RELATED IMPACT

Attitudinal factors are not the only ones which are shaping the future of interactive instructional television. A continuing controversial issue surrounding interactive instructional television and other automated training approaches is the technology's perceived potential for reducing employment among educators. Such concern about the displacement of classroom instructors and training specialists is grounded on the assumption that teaching machines are more effective than humans. However, the exaggerated fear that educators

will somehow be squeezed out of their jobs by cold, impersonal machines is totally unfounded. In fact the educational applications of interactive instructional television will serve to stimulate, rather than stifle employment. This is because instructional programs to be used with the technology have to be developed: the machines can not do this . . . yet!

Today, our nation is in the midst of an upheaval which is shaking the very foundations of our major industries. Education and training institutions are facing perhaps the most challenging task that will ever confront them: preparing people for employment in new and emerging occupational fields, and retraining unemployed people with obsolete or minimal skills. It is fitting that, in meeting this challenge, they are able to use technology---as exemplified by interactive instructional television---to teach technology.

Advances in technology are really meaningless without the simultaneous development of skills of those who will be working alongside the technology to develop the program material that constitutes the system's "heart and soul". Interactive instructional television demands highly qualified creative professionals if it is to flourish and fulfill its potential. It is evident that several critical skills are needed for success in developing program materials for interactive instructional television. These include, flow charting, scriptwriting, video production and basic computer programming.

In this section of the final report, we will examine, in detail, the process of designing program materials for use with interactive instructional television.

Perhaps the most crucial factor in the design of any interactive instructional television program is flexibility. The program must anticipate the needs of the learner and meet these needs in a variety of ways that so satisfy the requirements of the educational institution which has adopted the new technology as a means of delivering instructional services. Because of this, the design of most interactive television programs often becomes a group effort, taking advantage of the varying perspectives and objective analyses of many instructional staff members. While most instructional design work begins customarily with a needs analysis, interactive instructional television requires a far more extensive analysis, than other media program development requires. In essence, one has to "dissect" the instructional objectives very thoroughly, so as to make sure that one provides material that will appeal and motivate and teach at various student competency levels.

For instance, a vocational training program produced as a manual or in an audiovisual format may begin with some basic skills necessary for successful apprentice level work and end with a few examples showing how these skills are applied in the workplace. An interactive instructional television program dealing with the topic would be so constructed as to allow learners who are already familiar with some basic aspects to skip ahead, while at the same time insuring that those basic skills are reviewed and understood by all students. In other words, you do not force all learners to go through all the basic material but you do design the

program so that no learner could complete it without understanding the basics presented in the earlier instructional segment.

Also, due to the large number of systems on the market it is important to provide detailed instructions for users who may be unfamiliar with the equipment involved, which is being used at the moment. For example the microcomputer component of one system may require the student to press the "BREAK" key to start over again, while another may ask the student to press a combination of keys to reset the system. Without understanding the commands and the language of the system in use, the learner could find it impossible to "cancel out" an erroneous entry and start over again.

To prevent this problem many interactive programs include a special "help" function that can be called up at any time, when initiated by the learner. This signal usually fills the display screen with a list of commands and explanations of what they will cause the system to do.

Most of the material needed by the learner to "run" interactive programs is included in a "menu" of some kind, either written on paper or provided within the interactive system's computer memory system or both. At times, this menu is found on a "directory" that lists the various titles which are included within the specific program being worked with. An important part of the instructional program developer's job is making sure that such titles are as descriptive and interesting as possible. Many instructional program designers begin each segment with some question or problem that will operate to intrigue the learners and thus get them involved. It is also important to balance the length of each segment to insure that the learners do not become bored with the process of answering questions or determining solutions to problems. An interactive instructional television program needs to be somewhat like a patchwork quilt; each individual segment needs to stand alone, yet come across as part of a larger pattern. Only rarely will the learner see the overall pattern, or even need to see it. Instead, he or she needs to concentrate on small combinations of segments that are carefully programmed or "arranged", so as to form a minor pattern in the "grand design".

Such minor patterns are referred to as "branches." These should be nonlinear in nature. That is, the program unfolds more like to the give-and-take of a "live" tutorial interaction with a "master" teacher than a "canned" lecture. When correctly designed, interactive programs can be just as effective as "live" tutorials in giving the learners the information that is most important to them.

In many respects, the key to effective design of an interactive branching program can be the "conditional" or "If, then" statement. this is the standard form familiar to anyone who has completed a course in basic logic. For example, if all fish have scales, and this is a fish, then it has scales. if one thing is true, then the other follows; if one thing happens, then the next thing will happen.

In interactive instructional television program design, the "If, then" statement often takes the form of a multiple choice question following a videotaped instructional episode presented to the student. If a student chooses a certain answer, then a certain sequence of events is set in motion. Perhaps the student chooses answer "B" when asked a question concerning the proper way to take an oral temperature. If answer "B" is correct, then the participant is allowed to move to the next learning segment in the area of taking a patient's vital signs. But if the answer is wrong, the participant may be sent back to the beginning of the previous segment or to some special branch within that segment that provides the information required to answer the question correctly.

The "If, then" statement is a standard form for most "authoring" languages used in developed interactive instructional television programs. In other words, the computer "understands" what the author "meant" and what to do when he or she phrases something as "if, then."

Obviously, not all instructional objectives can be accomplished using simple "If, then" formulas. For this reason, some instructional authoring languages allow the instructional program designer to set ranges and limits. For example: If the student answers "A" once and is then advanced to a specific branch; if he or she answers "A" twice, the strategy may be one of going to the main branch and repeating the entire segment. If the student answers "C" three times, he/she may be shunted to a list of suggested readings for detailed "help".

In some cases, "If, then" statements can refer back to prior performance of the student stored in the computer's memory. For example, if the student has a 90% average so far, the computer is told to allow him or her to continue even if this particular answer is wrong.

Although an interactive instructional television program obviously cannot observe and analyze all the subtle hints a human tutor can use to track the student's understanding, an "If, then" statement does permit some "diagnosing" to be used. Just as a physician can diagnose a patient's physical ailment by asking a series of questions, searching for an overall patterns, so can a carefully designed interactive program use the answers given by the student to a number of questions to identify a pattern that indicates not only a lack of comprehension, but also the specific problem area giving the student trouble. Then, once that area is spotted, "If, then" statements can be used to send the learner to a "remedial branch" containing instruction designed to remedy his or her difficulty with the specific problem.

Clearly, the challenge for the interactive instructional television program designer is one of creating program materials that <u>isolate</u> the information and competencies required of learners. It could well be that each answer to each question should lead the student to a different program branch. Accomplishing this is more

difficult than it sounds, at first blush. This is because the designer has to provide enough information to cover the topic without presenting so much extraneous material that the learner is bored and thus "turned off".

When using computer-controlled interactive instructional television systems, one can refine the "If, then" statement even more than discussed above, thus helping to insure that students receive all the precise information they need about a given topic. This is done through the use "and, or" logic statements. Today's computers use devices known as "logic gates" to process the information that makes them work so well. These are electronic circuits that act like light switches. An "or" gate is like a light circuit that can be turned on or off from two locations; if either light switch is flicked, the light goes on. If a signal is received at either one or the other of the inputs to a computer "or" gate, a signal results. In contrast, a computer "and" gate requires that the same signal be received at both inputs. In other words, if input "A" and input "B" are present then a signal comes out.

If one's intention is to design an interactive program and then give it to an interactive instructional television programmer to place on the "system", then one does not need a comprehensive understanding of computer language. However, one does need to understand how these "and" and "or" gates can be used to define various program elements, so that the approach you specify can take full advantage of what they have to offer.

The components just discussed are called "gates" for a good reason: They either let something through to a "pathway" or prevent entrance. A major advantage of the computer as an aid to interactive instruction is not its "intelligence", but its patience. The computer will carefully check each possible gate until it finds a pathway---and will do it in less time than that required to blink an eye. Consequently, you can block passage to another level of instruction by requiring that the student meet certain parameters that you specify. The parameters set up can be quite sophisticated. For example, you can require that the student provide the correct answer to three questions within a certain time span or else specify that he or she be sent back for remedial instruction. This seemingly simple contingency may require that the computer make dozens of comparisons and decisions, including a timer circuit: "If questions 1 and 2 and 3 are answered correctly, and the three correct answers are given withing 30 seconds, then go to the main branch; if question 1 or 2 or 3 is answered incorrectly, or the three answers aren't given within 30 seconds, then go to a remedial branch" and so on.

AN EXAMPLE INTERACTIVE INSTRUCTIONAL TELEVISION PROGRAM

For the purpoess of illustration, assume that you are a vocational instructor training students in small engine repair techniques. To be successful in one basic module of your course the

students need (1) a good basic understanding of how small engines function and (2) specific knowledge concerning operation of the various parts, and potential common malfunctions. The latter requires extensive, rote practice in assembly and disassembly of engines being worked with. From a training standpoint, and instructional design standpoint, the need can be stated in a very general form. That is, if the student understands the basic concept of small engine function and the common causes of malfunction, he or she can be said to have successfully accomplished this particular section of the course.

With this basic form, you can create program material that addresses the basic competencies required. And you can create questions and answers that test understanding and provide branches to follow if his or her understanding of essential course content is "not up to par". To further illustrate, assume you are using a videotape unit that has massive storage capability (up to 8 hours) In this case several program modules might be included on the same tape. Consequently, in designing the instructional program, the learner is first sent to a directory, perhaps first by pressing the "D" key on the computer keyboard. This would call up a listing of all of the programs contained on the videotape. If this were the learners first encounter with the interactive instructional television system, perhaps he or she would then call up the directory listing entitled, "HOW TO USE." Of course, if you wished, you could make the "HOW TO USE" feature an automatic part of every program to be shown as soon as the tape was inserted into the machine. If so, you would want to provide a means for students who have already seen the program to skip the introduction and go on to another listing. If desired, you could also require each student to use a specific password to call up programs. There are two good reasons for using this feature; first, individual passwords give you a means for identifying each student. In some interactive systems the same computer that delivers the instruction is used to help the teacher by monitoring and recording each student's responses, even permitting later review of student performance data by access to selected programs, preventing students from jumping ahead of the prescribed sequence. For example a student might have to answer successfully one or more comprehensive questions at the end of a given instructional program sequence, before the computer releases the password that permits him or her to progress on to the next level.

Again, for the purpose of illustration, suppose that an interactive instructional program one of your students is working with begins with an introductory segment that outlines basic concepts and terms. The segment ends with a test. Students who complete the test successfully are allowed access to the next segment. Those who fail obviously require more comprehensive training. It is at this point where the "And, or" segments built into the computer program can help you identify specific problems and correct them with specialized training segments.

The challenge to the interactive instructional television program designer is to set up the program in such a way that the answers chosen by students to combinations of questions tell the computer which specific segment of material needs to be covered in more depth. As we indicated earlier, the use of "and" and "or" statements allows you to do this with remarkable precision.

For example, assume that a student answers question 1 correctly, showing clearly that he or she understands the basic concept being dealt with, but misses questions 2 and 3, which deal with specific instances of small engine malfunction.

In a situation like this, the computer has three distinct items of information about this particular learner. That is, he or she knows the basics, but does not understand the small engine malfunctions. Based on this information, the computer can call up a new proram segment or recall the specific part of the introductory segment that discusses the information which the student failed to learn. In the program development stage, by using "And, or" "If, then" logic, you may have told the computer that the student must provide the correct answer to question 1 and question 2 or question 3 to complete that segment. This being the case, if the student correctly answers question 1 and 2 or question 3, then he or she moves on. If the student misses on question 1, then he or she does-not get a chance to answer 2 or 3. Instead, the basic concept is explained more fully. If the students answer 1 correctly but miss 2 and 3, the small engine malfunction subject matter is explained more fully.

From the foregoing, the potential of interactive instructional television learning should be clear. The approach permits design and delivery of instructional programs that directly and precisely address the individual needs of each student while still meeting delineated instructional objectives. As with most good things, however, there are also potential pitfalls in interactive instructional television system design: If one does not ask the right questions, and does not provide the right answers, then the program will be a disaster! To complicate matters, there is no human instructor present to make needed adjustments or solve problems on the spot. Clearly, with interactive instructional television programming and design are of critical importance. Everything has to be right before the student sits down and starts his or her interaction with the program. For example, an "If, then" statement must make logical sense and must accurately define the information you want the student to understand. If your logic is faulty ("If all fish have scales, and this object has scales, then this is a fish"), so will be your instruction!

It makes sense to use a flowchart for any interactive instructional television program developed. This is a symbolic representation of the steps involved in the program being designed.

From the flow chart shown in figure 1, it is easy to see where the term "branching" came from. In the flow chart, training objectives form the main trunk up and down the chart while individual concepts, ideas or examples form the various branches.

You can readily see that the interactive instructional television program charted in figure 1 contains at least one potential design flaw; unremediated program branches. Until the student answers the first self-test question correctly, for instance, he or she will keep returning to the same introductory section. The problem is either that the instruction in that particular section is faulty or the learner simply doesn't "get it", In any event, he or she will just keep reviewing the same material until guesswork or the process of elimination---produce the right answer---or until the student, justifiably frustrated---quits. Very probably, the program needs more remedial branches. Most definitely it needs a point (perhaps after the student has failed a self-test twice) at which the student is told to stop and seek help elsewhere to clear up the troublesome area.

It would be nice if we could assert that computer-based interactive instructional television systems are the answer to the harried, overworked teacher's prayer for an easier "time of it." Sadly all the computerization in the world will not make the teachers job any easier. He or she will still have to design the interactive program carefully to take full advantage of the precision possible with interactive learning. And, he or she will still have to be creative, making the program as flexible as possible. Also, he or she sitll must chart out the learning path with great care so as to make sure that there are no logic flaws in the instructional program, that will hinder---instead of facilitating learning.

This entire process involves a lot of work--more perhaps than is necessary to meet simple training objectives by conventional instruction. However, in the long run it is effort well spent. For, properly prepared, interactive instructional television can make the learning process more relevant, more interesting and more efficient---which is, after all, what the educational process is all about.

SUMMARY

As brought out in the body of this report, the evolution of micro-computer technology and advances made in videorecorders have resulted in the availability of cost-effective instructional strategies that were viewed as being science fiction a few short years ago. While the symbiotic relationship between video and computer technologies is becoming increasingly apparent, judged by the large number of hardware systems appearing in the market place, the use by educators of available technology is limited. Much greater use is seen in private industry.

Utilizing micro-computer control, which allows for branching instruction, users of interactive instructional television systems can access segments of various videotaped instructional material with speed and accuracy.

The learner receives information, is asked questions, and required to respond electronically using a responder device. Feedback

is immediate and can be personalized, with the information level of difficulty precisely controlled so as to match the individual's level of idiosyncratic pace and rate of learning.

Remedial information can be presented in the interactive system automatically, and it being possible, with some systems, to record and evaluate the learner's performance.

The systems available today provide for varying levels of interactivity---depending primarily on the cost of the system one elects to work with. Exceedingly complex systems utilizing laser videodisc playback units and expensive microcomputers can provide a very high degree of interactivity. In contrast, low-cost personal computers can be used with low-cost home-type videotape recorder-playback units (VCR's) to provide a reasonable degree of interactivity---economically. With such systems, students can be presented video taped segments of information, and then required to respond by entering the code appearing next to the answer they believe is correct. If a student's answer requires a particular feedback segment, the video-cassette player can access that particular segment before continuing to the next instructional segment.

The multistimuli available with interactive instructional television allow contextual learning which-reasearch has repeatedly shown---leads to enhanced transfer and recall of information learned.

RESULTS

In conducting this exemplary and innovative project, the staff focused attention on the several areas described earlier in discussion of the study objective. This section of the report sets forth the results of their efforts.

Requirement 1: To develop a package in given high technology subject matter areas, to be delivered via interactive video instructional means which teaches both cognitive and psychomotor skills.

In consultation with the project advisory council, which was composed of individuals knowledgeable in the broad field of vocational education, the following subject matter areas were identified to serve as focal points for developing actual interactive instructional television teaching programs: vocational office education (data processing), mental health/human services occupations, consumer education and vocational/industrial safety. Of interest to the staff in producing the instructional materials were such factors as time required for production of high quality instructional programs, cost considerations, technical difficulties one might encounter in primarily "on-location" production efforts, and the like. These are important considerations, in light of published reports concerning the "high cost" of producing interactive instructional television program materials. In this connection, Thomas Donanue, founder MicroMentor, Inc., a software development/computer consulting firm, wrote in the April 1984 issue of PC Magazine that "the possibilities for computer-video interactive applications are limitless. The only reason the market has not taken off is cost. To produce a 1-hour tape, MicroMentor spends from $100,000 to $150,000, depending on how complex the lessons are."

Considering the exceedingly sparse resources typically available in vocational education standards, it is understandable that costs such as those quoted above would be prohibitive and retard the use, in vocational education, of interactive instructional television. The project staff found that high quality interactive instructional television programs could be produced by a fraction of cost figures quoted by Mr. Donahue for MicroMentor instructional programs. Reasonable production costs prevailed all the subject matter areas dealt with, some of which involved considerable "on location" production effort. How was this possible?

(1) By capitalizing on advances which have been made in video technology. Today, sophisticated electronic equipment is available at a fraction of the cost of a typical professional broadcast system color televison cameras, videotape recorders, and tape handling (editing) equipment, the use of which by instructional program producers operates to keep production costs high. High quality video programs can be produced using the viewer generation of "home" video systems which have been produced around the ½inch beta and VHS videotape formats. With this format, it is possible to produce and make available up to eight hours of interactive instructional programming on a single video cassette that can be

purchased at some discount houses for under five dollars each. Compare this cost to the typical cost of a commercially available 30 minute motion picture film of video tape (which tends to cost up to $400 or more). That it is possible to produce high quality interactive instructional television materials using today's low cost video equipment can be verified by examining the programs developed by the project staff, which were listed earlier.

(2) By using multi-talented production staff. In today's instructional materials market place, production costs are remarkably high, due greatly to the large number of people involved in a given production effort: writers, directors, producers, sound engineers, lighting experts, electricians, grips, gaffers, etc. The high quality of work produced under the project for which this report was prepared, which were mainly "one person" production efforts, demonstrates very adequately that a large, expensive production staff is not necessary to turn out quality interactive instructional television teaching programs. Under most circumstances, a two-person production crew, cross trained in such basic skills areas as camera operation, sound recording, lighting and videotape editing, will be able to produce instructionally adequate materials at low cost.

Requirement 2: To identify the technical requirements of persons and equipment needed to develop a cost effective integrated interactive instructional television system.

The technical requirements of persons engaged in development of program materials for use on interactive instructional television systems was alluded to in the discussion of Requirement 1. The "core" equipment needed for an adequate, affordable interactive instructional television teaching station would require, as a minimum:

* A low-cost personal computer with 64 RAM

* An industrial quality videotape player. Standard home video recorder players at this point are not able to run interactive television programs because most switch from fast-forward to reverse mechanically. Industrial-quality players feature solenoids, which perform the switching maneuvers electronically.

* A television monitor, which adapts to either a composite (a regular television screen) or an RGB color input screen (like those used on personal computers), thus eliminating the need for the dual screens used by many interactive systems.

* An interface unit. This interface is a "black box" device that connects the videotape player to the computer and to a color monitor. A variety of "black boxes" are available, as can be seen by referring to the material contained in the appendix.

With these, or related components, it is possible for low-cost personal computers to control industrial type video tape recorders with frame-accurate precision via a standard RS-232 Serial Port. Some systems feature in the "black box" an internal microprocessor and up to 24K of RAM/ROM which efficiently translates simple user commands into complex VTR operations. Frame accurate location of specific video tape scenes is made possible by absolute addressing techniques which numbers each video frame and provides a Tape I.D. number. Some systems feature an internal video/audio switcher that permits one TV monitor to display composite video from either the video tape or computer. With most systems, command syntax is straight forward: "FIND 2000; PLYB 4000" causes the system to play the video tape from frame 2000 to frame 4000.

Commonly used, videotape recorder/playback units for interactive instructional television applications include:

SONY

Type V Series (VO-5000 - VO-5850), BVU Series, SLO-323, SLO-303I, SLO-383, SLP-305, SLO-325, VO-2011, VO-2611, VO-2811, VO-2850, VO-2860.

PANASONIC

NV-9240, NV-9600, NV-8200, NV-8170, NV-8500, AG-6100, AG-6200, AG-6300

JVC

CR-8250U, (CR-6400U w/dealer modification)

Personal computers commonly used for interactive instructional television applications include:

IBM PC, Apple, TRS Color, Sony, Columbia, Compaq (and with some "black box" interfaces, any personal computer with a RS-232 (CCITTV.24) serial communications interface feature).

Requirement 3: To define appropriate high technology subject matter content areas for which the integrated, interactive instructional television system promises to be the most applicable and cost effective.

The project advisory council agreed unanimously that this new instructional technology could be used advantageously in virtually all areas of industrial/vocational education currently being carried on in the public school environment, to provide competency-based, individualized self-paced instructional opportunities. Their unanimity was attributable to the fact that in such systems, a videotape can be made up of "real-life" situations involving virtually any component associated with vocational skills development. These situations can be interspersed with stopping points at which the student is questioned to determine whether or not the subject matter content presented has been mastered. Then, based on the way the

student responds to the questions, the system branches to a different point, either to present new subject matter content, or to present needed remedial material. The student studies at his or her own pace, and can proceed more quickly if the material is mastered promptly. Misconceptions can be corrected very early. Interactivity also makes it possible to sequence individual parts of a program outside of the traditional learning-testing context. For example, a demonstration of real life situations which will be encountered in daily work on the job for which training is being provided can be presented quite readily, to add realism and relevance to the educational process. This feature alone commends the instructional approach for use in virtually any high technology subject matter area.

Requirement 4. To define the educational technology needed to develop effective educational packages for delivery via the integrated, interactive instructional television approach.

For many years, educational technologists have wrestled with finding a way to merge---on a cost-effective basis---the components of traditional instructional television systems with the computer, which constituted the heart of computer assisted instruction systems. Such would permit focusing the attributes of motion, sound and color---interactively---in the instructional process. What was needed to permit this was an integrated cost-effective, interactive system capable of being managed by a low-cost computer on a stand-alone basis, according to individual student needs. Fortunately, a fortuitious combination of technological circumstances has taken place recently which provides a solution and promises unusual new opportunities in education; via the integrated interactive instructional television approach. This is because, as stated earlier:

1. Video materials have become easier and less costly to produce, manage and deliver, as a result of advances in the $\frac{1}{2}$inch videotape format.

2. The personal computer has grown smaller and less expensive to utilize.

3. Computer/Video Interface "black boxes" have been developed which allow the methodologies of instructional television and computer assisted instruction to work together easily.

4. Programming approaches have evolved which permit non-computer programmers to develop instructional software needed for interactive instructional television applications.

With these new technological approaches, an inexpensive videotape player can be used to reproduce highly effective instructional sequences, with the computer helping the student understand them. At the same time, the small, low cost personal computer can be used to diagnose learning problems and to present remedial material generated by the computer or that which has been stored on videotape for "call up". Additionally, the computer component can take

note of a student's progress and store the information in the form of useful data. This allows managemnt of the student's instruction by an infinitely patient computer system while at the same time under teacher supervision and control.

With this new technology, teachers can be freed of many repetitive teaching tasks, so as to give increased attention to individual learner needs, needs which require the application of the teacher's intelligence and human sensitivity.

ESSENTIAL ELEMENTS OF EDUCATIONAL TECHNOLOGY PERTINENT TO IMPLEMENTING INTERACTIVE INSTRUCTIONAL TELEVISION

Most of the interface units or "black boxes" which are essential for making interactive instructional television systems work involve special circuitry, cables, connectors, and diskette operating software---all of which are needed to fashion the videotape recorder and personal computer into a smoothly functioning integrated instructional unit.

Another essential component in this new educational technology is the lesson development, or "authoring" system. This component permits the non-computer programmer-optimally the teacher--to create the interactive instructional television lessons or software. To be maximally useful, an authoring system should permit the lesson designer to:

---choose plain language commands from computer screen menus. These are typed in the order desired, so as to tell the computer--step by step--how the lesson should be conducted and what should happen whenever the student makes certain choices.

---The lesson developer typically can call for any mixture of lesson events, with the student being required to answer questions at any desired point in the instructional program.

The system used to develop an interactive instructional television lesson should provide for:

---Any number of videotape segments to be played in any order desired.

---Text material to be typed on the keyboard by the lesson developer for storage and access as needed.

---Administering either multiple choice or keyword matching questions.

---Provide for instruction for computer to branch to remedial videotape material should the computer's analysis of the student's answers indicate the need for remediation or clarification.

KEY COMPONENT FEATURES

A VIDEOTAPE MANAGEMENT CAPABILITY--This feature is needed to allow direct control over videotape player functions from the computer keyboard. This makes possible easy identification of selected tape segments by numerical address. It also reads out timing information and creates files of useful data.

A PROGRAM EDITOR CAPABILITY--allows a lesson developer to structure a lesson into a series of EVENTS, with an EVENT being a series of videotape sections. Or, an EVENT can be set up as a question which requires the student to respond (by typing an answer on the keyboard.)

The program editor feature asks the lesson developer for needed information, if appropriate. For example, in some advanced systems, if the lesson developer types in

P L A Y

The computer asks him or her

P L A Y T O P O S I T I O N _____ ?

Where upon the lesson developer simply types out the numerical tape address of the desired videotape material established earlier by the program editor feature. It can be seen readily that such capability greatly simplifies the lesson development process.

Other simple operating commands characteristic of some program editor configurations include:

SEEK...An instruction telling the computer to find a tape section.

SHOW...An instruction telling the computer to find and show a tape segment.

VTR... A command to have the computer switch video to tape.

TEXT...A command to cause the computer to print text on the screen.

REPEAT...A command to have the computer repeat the question.

Other special purpose commands encountered in some systems include DELAY. With this command the lesson developer can instruct the computer to hold information on the screen for any time interval desired. The lesson developer types the number of seconds for the delay and the command is written into the program automatically. This can be quite useful in structuring certain lessons, where time of exposure is critical.

By using the command PRINT, some lesson development programs can produce a plain language listing of EVENTS and SUB-

EVENTS to the TV screen or to a line printer for periodic "hard copy" convenience.

Another useful feature of some available lesson development strategies feature special time coding. This is an innovation which automatically places a digital code on the videotape. The code prevents buildup of errors in tape access. It also assures that dead-accurate tape location information is available to the computer even if the tape is not rewound to the beginning. It also allows access of data (including high resolution color graphics) from the computer's disk operating system at the same time the computer is operating the tape player. The availability of time coding means that the computer never loses track of tape location and so is able to perform a number of tasks simultaneously, permiting great versatility and flexibility in lesson development.

Fortunately, lesson development systems are available which feature branching capability. This permits "programming" special event routes into the lesson, so as to accomodate special learner needs. Available options include such things as...

1. Allowing the student to request extra help from the computer keyboard.

2. A decision being made by the computer that a particular student needs extra help.

3. Allowing the student to challenge a section of instruction if he or she feels that it has been adequately learned already.

4. A decision being made by the computer to move the student ahead as the result of his or her test performance.

Also, in some systems, typing the word JUMP as the program is being written, allows the lesson developer to specify material that can be skipped. At this point, the lesson developer defines the conditions under which the special route will be established.

If the lesson developer desires, the student can be given the option to JUMP a section of material. In such cases, the lesson developer provides for a "READINESS GATE" to check the student's qualifications for the JUMP written into the lesson sequence.

By allowing special text and/or graphics files of expanded explanations to be created, the better lesson development systems allow delivery of supplemantary explanations to the student who does not quite understand a particular facet of the instruction being presented.

Such special explanations can be accessed and delivered to the TV screen when a student response indicates that some difficulty is being encountered. For example, the lesson developer can ask the student . . .

How may we help, Joe?

Upon recognizing a given key word in the student's answer, the system can display the required explanation, show a special section of videotape, or suggest special reading material to the student, as an outside resource. Explanations can also be printed out by the line printer as "hard copy" to be retained by the student as reference material.

Some systems can be programmed to deliver a HINT to HELP a student solve a particularly toublesome problem, or to help him or her to answer a given test question. When this occurs, the system usually uses the HINT capablity.

The more useful lesson development systems from which the educator can choose also automatically generate a file of student response information for later evaluation by teachers or for computer analysis as desired. With these, lessons are prepared typically so as to reuest the student's name at the beginning of the instruction. From that point on, all lesson performance is tracked, with the student responses being filed. Student answers to questions---including all text typed by the student can be preserved on disk storage, screen display or paper printout, as the lesson developer desires.

The more technologically advanced lesson development systems are "user friendly"---not only in terms of the authoring process, but also in terms of program delivery to students. Under author control, the better systems can respond promptly to student requests for hints or other special attention---and can even use the student's name in referring to strategies designed to meet his or her needs.

The educational technology exemplified in the interactive instructional television, merits serious consideration by all vocational educators. This is because our country is in the midst of a massive technological upheaval which is shaking the very foundations of our major industries---manufacturing, automotive, and telecomunications. Education and training institutions are facing perhaps their most challenging tasks: preparing people for employment in new emerging occupational fields, and retraining unemployed people with obsolete or minimal skills. Because it uses technology to teach technology, the project staff and advisory council believe the interactive computer video system for teaching high technology subject matter represents a significant step toward training for the future.

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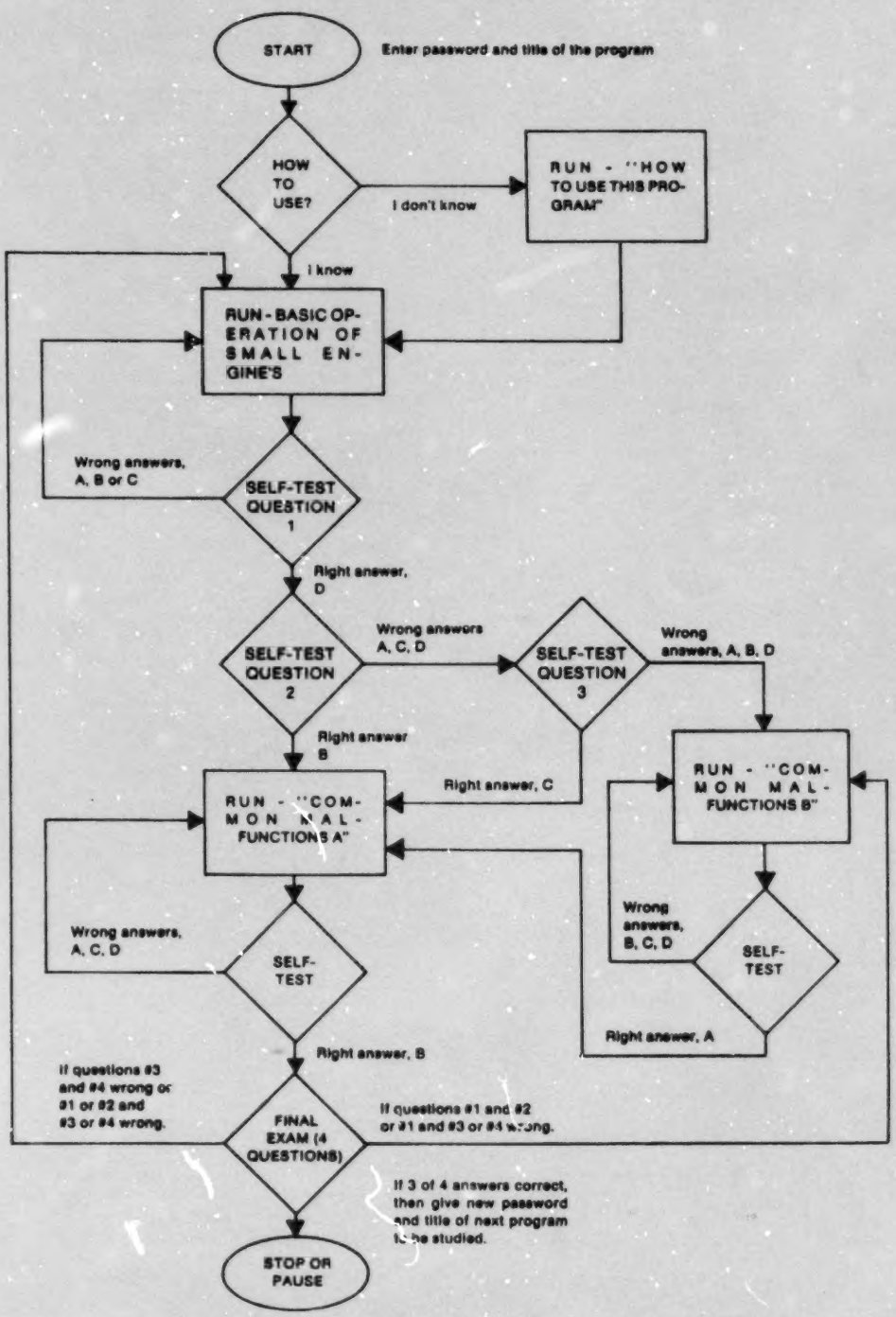
Figure 1. Example Of An Interactive Instructional Television Program Flowchart Dealing With An Introduction To Small Engine Repair


START
Enter password and title of the program
HOW TO USE?
I don't know
RUN - "HOW TO USE THIS PROGRAM"
I know
RUN - BASIC OPERATION OF SMALL ENGINE'S
Wrong answers, A, B or C
SELF-TEST QUESTION 1
Right answer, D
SELF-TEST QUESTION 2
Wrong answers A, C, D
SELF-TEST QUESTION 3
Wrong answers, A, B, D
Right answer B
Right answer, C
RUN - "COMMON MALFUNCTIONS A"
RUN - "COMMON MALFUNCTIONS B"
Wrong answers, A, C, D
SELF-TEST
Wrong answers, B, C, D
SELF-TEST
Right answer, B
Right answer, A
If questions #3 and #4 wrong or #1 or #2 and #3 or #4 wrong.
FINAL EXAM (4 QUESTIONS)
If questions #1 and #2 or #1 and #3 or #4 wrong.
If 3 of 4 answers correct, then give new password and title of next program to be studied.
STOP OR PAUSE